This invention relates to blasting explosives. More particularly, this invention relates to substantially water-resistant, explosive gels containing ammonium nitrate.

Blasting explosives in aqueous slurry or gel form have been used extensively heretofore. When such blasting explosives contain nitroglycerin, there is an ever present danger of accidental detonation as well as the headache-producing effect of the nitroglycerin vapors. There is also a possibility of accidental detonation of aqueous slurry type and gel type blasting explosives which contain trinitrotoluene and/or other high explosives.

Only recently blasting explosives have been made available in the form of aqueous slurries of ammonium nitrate containing various additives. Ammonium nitrate is not subject to uncontrolled explosions and does not produce vapors that are detrimental to operating personnel. Although these aqueous ammonium nitrate blasting explosives overcome the hazards encountered with other fluid explosives, one of the disadvantages inherent in the use of aqueous slurries of ammonium nitrate is that the ammonium nitrate is readily soluble in water. When such a blasting explosive is poured into a bore hole which already contains some water, the blasting explosive may become substantially diluted, and as a result the explosive power of the blasting explosive is reduced significantly. There is a great need at the present time in the blasting industry for a pourable blasting explosive which is free from unprogrammed explosion hazards, noxious fume hazards, and which is substantially non-penetrating by water or other fluids normally encountered in blasting environments.

It is a primary object of this invention to provide a novel blasting explosive which overcomes the disadvantages inherent in blasting explosives available in the prior art, and which supplies the needs of the blasting industry.

A further object of the invention is to provide a blasting explosive gel which is substantially devoid of oversensitive components.

Still another object of the invention is to provide a novel explosive gel which is substantially devoid of noxious fumes.

It is another object of the invention to provide a novel process for preparing water resistant explosive gels.

Another object of this invention is to provide a novel process for preparing blasting explosives.

Still another object of this invention is to provide an improved cross-linking agent for thickening agents employed in the preparation of gel type explosives.

A further object of the invention is to provide an explosive gel composition containing powdered aluminum wherein corrosion of aluminum is inhibited.

These and other objects of the invention will be apparent from the following detailed description thereof. It has now been discovered that a porabibe, substantially water-resistant explosive gel is formed by admixing ammonium nitrate, metal particles, and water with a gel forming proportion of a mixture of guar gum and potassium dichromate. The novel blasting explosive gel of this invention can be stored for extended periods without the danger of unprogrammed explosion. In addition the novel blasting explosive gel of this invention may be poured into water, for example, into a bore hole containing water, without the danger of significant dissolution of the gel by the water contained in the bore hole.

Ammonium nitrate in any convenient form, such as commercially available crystals, prills, and the like, may be employed. The particle size of the ammonium nitrate is not critical, and any size that is readily dissolved in water is preferably used.

A powdered metal such as powdered aluminum, powdered magnesium, and mixtures thereof, is added with agitation to the aqueous solution of ammonium nitrate, or to gel formed therefrom. The powdered metal may be in either the atomized form or the flake form, or any other convenient form so long as the particle size is small enough to permit the particles to pass through an 80 mesh standard screen, and preferably through a 100 mesh standard screen.

The viscosity of the aqueous solution of ammonium nitrate containing powdered metal is increased by the incorporation therein of a suitable thickening agent such as guar gum, and a small proportion of a cross-linking agent such as potassium dichromate. The gel forming ingredients, guar gum and potassium dichromate, serve to maintain the resulting mixture in a water-resistant gel form. These agents do not prevent contact between the ammonium nitrate and the water originally in the explosive composition, but they do prevent additional water from entering into the composition and leaching out the explosive ingredients. This characteristic permits the novel composition of this invention to be charged into wet locations such as bore holes containing water or other targets submerged under water without mixing with the water surrounding the charge. In such an operation, the composition falls as a substantially immiscible liquid through the water to the bottom of the bore hole. In the absence of the cross-linking agents, the explosive composition dissolves in water, thus resulting in severe dilution of the ammonium nitrate and in dissipation of the explosive strength of the composition.

Another desirable advantage inherent in the novel explosive gel of this invention is that the dichromate cross-linking agent inhibits corrosion of the metal powder component and thereby markedly improves the stability of the gel when stored for extended periods prior to detonation. Other chromium salts may also be used as a cross-linking agent.

Listed below are the operating proportions and the preferred proportions, in percent by weight, of the components employed in making the novel blasting explosive of this invention.

<table>
<thead>
<tr>
<th>Components</th>
<th>Operating Proportion, Percents by Weight</th>
<th>Preferred Proportion, Percents by Weight</th>
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<tbody>
<tr>
<td>Ammonium Nitrate</td>
<td>5-80</td>
<td>40-70</td>
</tr>
<tr>
<td>Potassium Dichromate</td>
<td>0.01-0.4</td>
<td>0.1-0.3</td>
</tr>
<tr>
<td>Guar Gum</td>
<td>0.05-0.8</td>
<td>0.4-0.6</td>
</tr>
<tr>
<td>Powdered Metal</td>
<td>3-50</td>
<td>10-200</td>
</tr>
<tr>
<td>Water</td>
<td>3-50</td>
<td>20-45</td>
</tr>
</tbody>
</table>

The proportion of water set forth in the above table is the total water used in the preparation of the novel explosive composition. This water may be added separately to a mixture of the other components in an aqueous form, or it may be employed to form a solution and/or slurry with some or all of the components of the explosive composition prior to mixing. The novel gel forming effect may also be obtained when the metal is omitted.

In another embodiment of the invention, the gelling agents are added stepwise to permit hydration of the guar gum. For example, about 70 percent of the guar gum is added to an aqueous solution of ammonium nitrate and permitted to hydrate for about two minutes. Then
about 20 percent of the potassium dichromate is added to the resulting mixture and stirred for about three minutes. The remainder of the potassium dichromate is then added to the resulting syrupy solution. A mixture of powdered aluminum or magnesium, and the remainder of the guar gum is then added with stirring for about an additional three minutes. Other variations in the order of mixing of the ingredients may be employed without departing from the spirit of the invention.

The following example is presented to illustrate the invention without any intention of being limited thereby. All parts and percentages are by weight unless otherwise indicated.

**Example 1**

To 100 grams of a 50 percent aqueous ammonium nitrate solution was added 0.2 gram of potassium dichromate with stirring, followed by the addition of 1.75 grams of guar gum to yield a homogeneous syrup. To the syrup was added 15 grams of flaked aluminum, and after agitation to disperse the aluminum in the syrup, the resulting dispersion was allowed to stand at room temperature. At the end of about 15 minutes a homogeneous gel was formed.

Gels of the type described can be detoned with conventional caps and boosters such as penterythritol trinitrate (PETN).

For purposes of comparison, an aqueous solution of ammonium nitrate (50 parts water and 50 parts ammonium nitrate) were admixed with 1.75 parts of guar gum and 15 parts of flaked aluminum. No gel formed and after 48 hours the aluminum flakes settled to the bottom of the slurry.

Various modifications of the invention, some of which have been referred to above, may be employed without departing from the spirit and scope of this invention.

What is desired to be secured by Letters Patent is:

1. An explosive gel composition comprised of ammonium nitrate, water, and a gel forming proportion of a mixture of guar gum and potassium dichromate.

2. The composition of claim 1 having uniformly dispersed therein a powdered metal selected from the group consisting of aluminum, magnesium, and mixtures thereof.

3. The composition of claim 2 wherein said powdered metal is aluminum.

4. The composition of claim 2 wherein said powdered metal is magnesium.

5. An explosive gel composition comprised of a substantially homogeneous mixture containing between about 5 and about 90 percent by weight of ammonium nitrate, between about 3 and about 60 percent by weight of water, between about 0.01 and about 2.0 percent by weight of potassium dichromate, between about 0.03 and about 5.0 percent by weight of guar gum, and between about 3 and about 50 percent by weight of a powdered metal selected from the group consisting of aluminum, magnesium, and mixtures thereof.

6. The composition of claim 5 wherein said powdered metal is aluminum.

7. The composition of claim 5 wherein said powdered metal is magnesium.

8. An explosive gel composition comprised of a substantially homogeneous mixture containing between about 40 and about 70 percent by weight of ammonium nitrate, between about 20 and about 45 percent by weight of water, between about 1.0 and about 3.0 percent by weight of guar gum, between about 0.5 and about 1.0 percent by weight of potassium dichromate, and between about 10 and about 25 percent by weight of a powdered metal selected from the group consisting of aluminum, magnesium, and mixtures thereof.

9. The composition of claim 8 wherein said powdered metal is aluminum.

10. The composition of claim 8 wherein said powdered metal is magnesium.

11. The process for preparing an explosive gel which comprises the steps of admixing an aqueous solution of ammonium nitrate with a powdered metal selected from the group consisting of aluminum, magnesium, and mixtures thereof, and a gel forming proportion of a mixture of guar gum and potassium dichromate, for a sufficient time to yield an explosive gel.

12. The composition of claim 11 wherein said powdered metal is aluminum.

13. The composition of claim 11 wherein said powdered metal is magnesium.

14. The process of claim 11 wherein the resulting explosive gel contains between about 5 and about 90 percent by weight of ammonium nitrate, between about 3 and about 60 percent by weight of water, between about 0.03 and about 5.0 percent by weight of guar gum, between about 0.01 and about 2.0 percent by weight of potassium dichromate, and between about 3 and about 50 percent by weight of a powdered metal selected from the group consisting of aluminum, magnesium, and mixtures thereof.

15. The process of claim 14 wherein said powdered metal is aluminum.

16. The process of claim 14 wherein said powdered metal is magnesium.

17. The process of claim 11 wherein the resulting explosive gel contains between about 40 and about 70 percent by weight of ammonium nitrate, between about 20 and about 45 percent by weight of water, between about 1.0 and about 3.0 percent by weight of guar gum, between about 0.5 and about 1.0 percent by weight of potassium dichromate, and between about 10 and about 25 percent by weight of a powdered metal selected from the group consisting of aluminum, magnesium, and mixtures thereof.

18. The process of claim 17 wherein said powdered metal is aluminum.

19. The process of claim 18 wherein said powdered metal is magnesium.

References Cited in the file of this patent

**UNITED STATES PATENTS**

<table>
<thead>
<tr>
<th>Number</th>
<th>Inventor</th>
<th>Date</th>
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<tbody>
<tr>
<td>3,072,509</td>
<td>Bainhart</td>
<td>Jan. 8, 1963</td>
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